16-3004-101

Williams®

Instruction Manual

ROM SUMMARY

ROM	PART NO.	DESCRIPTION	LOC.	BOARD
SINISTAR 1B	A-5343-09961-A	PROM, 4Kx8, REV 1 (Brown)	1D	ROM
SINISTAR 2B	A-5343-09962-B	PROM, 4Kx8, REV 1 (Brown)	1C	ROM
SINISTAR 3B	A-5343-09963-B	PROM, 4Kx8, REV 1 (Brown)	1A	ROM
SINISTAR 4B	A-5343-09964-B	PROM, 4Kx8, REV 1 (Brown)	2D	ROM
SINISTAR 5B	A-5343-09965-B	PROM, 4Kx8, REV 1 (Brown)	2C	ROM
SINISTAR 6B	A-5343-09966-B	PROM, 4Kx8, REV 1 (Brown)	2A	ROM
SINISTAR 7B	A-5343-10150-B	PROM, 4Kx8, REV 1 (Brown)	3D	ROM
SINISTAR 8B	A-5343-09968-B	PROM, 4Kx8, REV 1 (Brown)	3C	ROM
SINISTAR 9B	A-5343-09969-B	PROM, 4Kx8, REV 1 (Brown)	3A	ROM
SINISTAR 10B	A-5343-10153-B	PROM, 4Kx8, REV 1 (Brown)	4C	ROM
SINISTAR 11B	A-5343-09971-B	PROM, 4Kx8, REV 1 (Brown)	4A	ROM
Special Chip 1	A-5410-09911	Special Chip	1F & 2F	ROM
Decoder ROM 4 (Horizontal)	A-5342-09694	PROM, 512x8	3C	CPU
Decoder ROM 6 (Vertical)	A-5342-09821	PROM, 512x8	3G	CPU
ROM 13A (Sound)	A-5343-10209	PROM, 4Kx8	IC12	SOUND
ROM 14A (Speech)	A-5343-10199	PROM, 4Kx8	IC4	SPEECH
ROM 15A (Speech)	A-5343-10200	PROM, 4Kx8	IC5	SPEECH
ROM 16A (Speech)	A-5343-10201	PROM, 4Kx8	IC6	SPEECH
ROM 17A (Speech)	A-5343-10201	PROM, 4Kx8	IC7	SPEECH
*ROM 18A (Sound)	A-5343-10140	PROM, 4Kx8	IC12	SOUND

*Used on rear sound boards in Cockpit Games only.

INSTRUCTION MANUAL
FOR
UPRIGHT AND COCKPIT GAMES

including …

- **operation**
- **bookkeeping**
- **adjustments**
- **diagnostics**
- **parts**

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CHAPTER 1 Game Setup

Warnings & Notices
Game Features
Examine your Game
Location of Controls

Warnings & Notices

WARNING:

1. **FOR SAFETY AND RELIABILITY, WILLIAMS** does not recommend or authorise any substitute parts or modifications of WILLIAMS Equipment.

2. **USE OF NON-WILLIAMS PARTS** and modification of game circuitry may adversely affect game play, or may cause injuries.

3. **SUBSTITUTE PARTS, MODIFICATIONS AND GAME "CONVERSIONS"** may void FCC type-acceptance.

4. **SINCE THIS GAME IS PROTECTED** by Federal copyright, trademark and paten laws, so-called game "conversions" may be illegal under Federal law.

5. **THIS "CONVERSION" PRICIPLE ALSO APPLIES** to unauthorised facsimiles of Williams equipment, logos, designs, publications assemblies and games (or game features not deemed to be in the public domain), weather manufactured with Williams components or not.

RF INTERFERANCE NOTICE:

CABLE ROUTING PLACEMENTS AND GROUND STRAP ROUTING on this game has been designed to keep RF radiation and conduction within levels accepted by FCC regulations.

TO MAINTAIN THESE LEVELS, reposition harnesses and reconnect ground straps to their original placements if they should be disconnected during maintenance.

Game Features

49-WAY OPTO-JOYSTICK

MODELLED AFTER A MILITARY AIRCRAFT JOYSTICK, the SINISTAR upright and cockpit joystick is engineered to fit the hand and provide quick game response as well as durability. Mini games have the space saving standard joystick but retain the new opto technology.

ELECTRONINCALLY THE JOYSTICK IS UNIQUE. Six opto-isolators (three on the X -axis and three on the Y-axis) are positioned to accept both direction and speed cues. A resolution of 49 directions and speed combinations is possible. See PLYER CONTROLS below.

STEREO COCKPIT SOUND

FOR THE FIRST TIME IN A WILLIAMS GAME we've included stereo sound! The new cockpit-style cabinet sufficiently encloses the player so that stereo sound will enhance the game experience.

TRUE STEREO. Since "true" stereo requires two sound sources, the SINISTAR cockpit game has not only two speakers, but two entire sound boards ... complete with two separate volume controls for maximum operator control!

SINISTAR SPEAKS!

CHALLENGE FROM A STAR. Just as the SINISTAR character is no mere twinkle on the night horizon, this is no ordinary video game! The SINISTAR character is the archvillian players love to hate. One of the best reasons why is that he **dares** them to challenge him!

ALL HIS WORDS ARE STORED IN ROM. A SINISTAR sound board addresses ROM chips on a separate speech board to access digitally-stored phrases. These phrases are converted from parallel to serial from on the sound board and then fed back to the speech board.

THE SPEECH BOARD THEN TRANSLATES incoming digital pulses into analogue form and filters the resulting analogue speech. Next the speech is mixed with the sound effects stored and D/A converted to the sound board. Finally the speech and effects travel back to the sound boards power amplifier chip and out of the speaker.

Examine Your Game

When you receive a new WILLIAMS game, examine it carefully before you power it up. Be sure that it was delivered in good condition!

- **INSPECT THE OUTSIDE of the shipping carton and/or** game cabinet for shipping damage.

- **UPRIGHTS & MINIS: UNLOCK AND SET ASIDE THE TOP REAR PANEL.** Undo the two trunk latches on the inside of the bottom door. Open the door. Now check circuitry.

- **COCKPIT GAMES: (1)** Unlock the cashbox door on the front of the game. **(2)** Now remove the cashbox and extend your arm to the left and right inside the door. Undo the two hood trunk latches. **(3)** Raise the hood. **(4)** Loosen the two access screws on the right side of the PC board panel. **(5)** Swing the panel up and to the left to inspect circuitry.

- **ARE THE CONNECTORS SECURELY ATTACHED?** Reconnect any found loose. DON'T FORCE CONNECTORS. They're **keyed** and only fit one way. By the same token take care: reversed edge-connectors can damage PC boards.

- **ARE PLUG IN CHIPS FIRMLY-SEATED** in their sockets?

- **UNWRAP** THE POWER CORD coiled inside the cabinet. Now position the cord in the wood slot beneath the bottom door. (cockpit games: Drop the plug through the hole in the floor. This hole is near the front of the game and under the PC board panel.) DON'T PLUG IN YET!

- **SCRUTINIZE MAJOR SUBASSEMBLIES,** such as the monitor, control panel, transformer board and power supply. Make sure they're securely-mounted.

Location of Controls

THE ON-OFF SWITCH is situated on the top left corner of upright games as you face the back of the cabinet**.** Cockpit games have an on-off switch beneath the cashbox door. The switch is positioned in the floor of the games front end.

THE VOLUME CONTROL in upright games is located inside the coin door and on the right cabinet wall as you face the game.

THE COCKPIT GAME HAS TWO VOLUME CONTROLS, one for each sound board. These controls are located near circuit boards under the games hood (below the hinged panel underneath the hood).

DIAGNOSTIC SWITCHES are on the back of the coin door in upright games. In cockpit games they're under the hood and on the top-right side as you face the front of the game.

These switches are used to access the Diagnostic-Mode tests, the BOOKKEEPING TOTALS screen and the GAME ADJUSTMENTS screen. Refer to the appropriate sections below for information on these important features.

OTHER CONTROLS. Finally they are five more controls that are used somewhat less often than those above:

(1) The **memory-protect interlock switch** is near the diagnostic switch bracket (see above). This switch must be open when you clear BOOKKEEPING TOTALS or make GAME ADJUSTMENTS. It automatically opens when the coin door is open on upright or mini games and when the hood is open on cockpit games.

(2) The **CPU board reset switch** is located across the CPU board from the batteries.

(3) The **Cashbox advance switch**, found inside the cashbox door on all models, allows bookkeeping information to be audited without permitting it to be zeroed.

(4) The **sound/speech mixer pot** permits the operator to balance sound/speech to suit his location. This pot is on the speech board on all games.

CHAPTER 2 Game Operation

Power Turn-On
Game Operation
Bookkeeping Totals
Game Adjustments
Definitions of Pricing Terms

Power Turn-On

CAUTION: This game must be plugged into a properly grounded outlet to prevent shock hazard and to ensure proper game operation. DO NOT use a "cheater" plug to defeat the ground pin on the line cord, and DO NOT cut off the ground pin.

WHEN THE GAME IS FIRST TURNED ON it produces a sound. Simultaneously general illumination should come on and a moment later a scanning “rug pattern”' indicating the RAM test should appear on the screen. Next the rug should become stationary as the ROM test is performed. In a correctly running game the rug pattern will be followed by the message "INITIAL CHECKS INDICATE ALL SYSTEMS GO". If RAM or ROM failure messages come up on the screen instead, refer to Power-Up Tests in TROUBLESHOOTING PROCEDURES.

Game Operation

GAME START

Insert coins; a random sound is produced and credits are displayed on the CRT. With two or more credits displayed, pressing **2-player start** initiates a 2-player, *3-turn game.

PLAYER CONTROLS

CONTROLLED BY THE JOYSTICK, a unique configuration of optoswitches provides a faster response and a greatly increased number of vectors in each quadrant for the precise aiming of your space ship.

TWO SETS OF THREE OPTOSWITCHS are each arranged at right angles to each other. One set is for aiming along the X-axis; the other is for aiming along the Y-axis. With the joystick in the centre position all six are blocked.

AS THEY JOYSTICK IS ADVANCED or pulled back it actuates one or both sets of switches. The spaceship responds with extraordinary precision due to the sequential action of the optoswitches in each set. Each switch in the set is offset so that the joystick action multiplies the circuitry brought in by the switches, increasing the precision action of the spaceship.

THE SPACESHIP ACCELERATES as the joystick is moved further from the centre position; it decelerates as the joystick is pulled or pushed back toward the centre position.

SPECIAL CIRCUITRY is included for the spaceship to respond immediately to sudden reversals of joystick movement.

PRESS FIRE! The spaceship fires at planetoids and also enemy **Workers** and **Warriors**.

PRESS SINIBOMB! When your **Sinibomb** is made with ore from the planetoid, you may press the **Sinibomb** button to destroy the **Sinistar**.

GAME PLAY

***YOUR INTERGALACTIC CRYSTAL-MINING MISSION** takes you to the antipodes of the known universe. But your parametric **DeepSpace** scanner faithfully displays the sector of the galaxy you presently occupy (including an area fully 3 parsecs across, no less)!

***KEEP THE GALAXY SAFE** for all it's sinizens! Fiendish **Worker** ships from the planet Sporg will attempt to fabricate a **Sinistar** from the remains of derelict planetoids in your very sector. You must not let them do this for two reasons:

(1) These planetoids contain the life-sustaining crystals that your civilisation requires for it's vital technologies.

(2) With the eminently unstable **Sinistar** in their possession, the Sprogites can lay waste to any civilisation in your sector. You alone stand in their way.

***YOU MUST MINE THE SINISITE CRYSTALS.** Williams has equipped you with the latest heuristic electret cannon technology. All you need to do is aim at a planetoid and shoot. Now collect your motherlode!

***IN FACT, ONLY WITH SINISITE CAN YOU MANUFACTURE SINIBOMBS** to eradicate the **Sinistar**. But you must also rebuff the **Workers** and disintegrate their even more aggressive comrades-at-arms, the evil skelomorphic **Warriors!** Intelligent beings everywhere depend on your courage, your dedication, your reserve, your shrewd command of tactical invention! It's up to you space cadet!

HIGH SCORE SIGNATURE

Select letters with the joystick. Push right to move forward through the alphabet; push left to move backward. Then push the FIRE button to lock in the letter.

---

*Adjustable Feature

Bookkeeping Totals

1. In Game-Over Mode, open the cashbox and depress the cashbox advance switch. The advance switch located on the diagnostic switch bracket can also be used. (See Figure 1.) The CRT should indicate all bookkeeping and evaluation totals. If so, go to step 3. If the CRT display comes up in the ROM test, perform step 2.

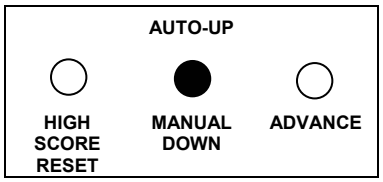


Figure 1. Coin Door Button Switches

2. Continue to depress the cashbox advance switch, stepping the game through test programs for ROMs, RAMs, CMOS RAMs, colour RAMs, sounds, switches, and then CRT test patterns, of which there are five. The fifth test pattern, colour bars, directly precedes the CRT display of the bookkeeping and evaluation totals.

3. The bookkeeping and evaluation totals appear on the displays as in Figure 2.

Figure 2. Bookkeeping Display

Clearing Bookkeeping Totals

1. Depress ADVANCE to display Game Adjustments.
2. Operate joystick Up or Down to position cursor on CLEAR BOOKKEEPING TOTALS.
3. Push FIRE Button.
4. Depress ADVANCE.

IF AVERAGE TIME PER CREDIT RUNS BELOW 1:30 (Figure 2), then more liberal **GAME ADJUSTMENTS** are recommended. What if AVERAGE TIME PER CREDIT runs over 2:30? Make the game tougher. Always try to keep AVERAGE TIME PER CREDIT close to the ideal of 2:00.

Game Adjustments

In the Game-Over Mode open the coin door. With the AUTO-UP/MANUAL-DOWN switch set to AUTO-UP, and depress the coin door ADVANCE switch twice to cause a CRT display as shown in Figure 3.

SELECT THE FUNCTION YOU WISH to change by moving the joystick (push up to move arrow up, down to move arrow down) Then, making sure the coin door is open, push the FIRE button to increase or SINIBOMB t to reduce the value of the selected function.

- Select the appropriate difficulty level by using the SINIBOMB (easier) and FIRE (harder) buttons (0 = easiest or liberal, 5 = average, 9 = hardest or conservative). *NOTE: The next two adjustments affect playing time by making extra ships easier or harder to win. Details are on page 12.*

- For a shorter game, increase the bonus points figure (FIRST EXTRA SHIP AT). For a longer game, reduce it. (1,000 = long / 99,000 = short).

- For a shorter game, increase ADDITIONAL POINTS PER SHIP AT. For a longer game, decrease it. (1,000 = long / 99,000 = short).

- For a shorter game, decrease the number of SHIPS PER GAME. For a longer game, increase the number. (1 = short / 99 = long).

GAME PRICING is selected with standard settings or with custom settings as shown in Table 1. Note that free play can be elected by entering the code number 9 at the PRICING SELECTION function.

FOR STANDARD SETTINGS you need change only the PRICING SELECTION. For custom settings, first set PRICING SELECTION to zero and then set the remaining values according to Table 1.

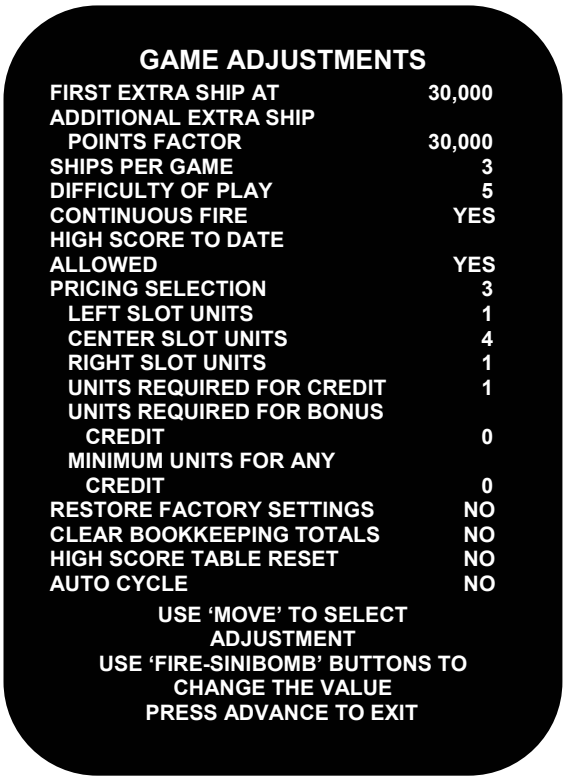

GAME ADJUSTMENTS
FIRST EXTRA SHIP AT 30,000
ADDITIONAL EXTRA SHIP POINTS FACTOR 30,000
SHIPS PER GAME 3
DIFFICULTY OF PLAY 5
CONTINUOUS FIRE YES
HIGH SCORE TO DATE ALLOWED YES
PRICING SELECTION 3
LEFT SLOT UNITS 1
CENTER SLOT UNITS 4
RIGHT SLOT UNITS 1
UNITS REQUIRED FOR CREDIT 1
UNITS REQUIRED FOR BONUS CREDIT 0
MINIMUM UNITS FOR ANY CREDIT 0
RESTORE FACTORY SETTINGS NO
CLEAR BOOKKEEPING TOTALS NO
HIGH SCORE TABLE RESET NO
AUTO CYCLE NO
USE 'MOVE' TO SELECT ADJUSTMENT
USE 'FIRE-SINIBOMB' BUTTONS TO CHANGE THE VALUE
PRESS ADVANCE TO EXIT

Figure 3. Game Adjustments Showing factory settings

HIGHEST SCORE SIGNATURE

The number of letters allowed the highest scoring player for entering his name can be varied from 3 to 20 and is recommended as 3. If objectionable words are entered as the signature name, you can change the lettered entry leaving the highest score the same. See **SETTING HIGHEST SCORE NAME.**

RESTORE FACTORY SETTINGS

1. Position cursor on RESTORE FACTORY SETTINGS.
2. Push FIRE button.
3. Depress ADVANCE twice.

RESETTING HIGH SCORE TABLE

1. Position cursor on RESET HIGH SCORE TABLE.
2. Push FIRE button.
3. Depress ADVANCE.

SETTING ATTRACT MODE MESSAGE

1. Position cursor on SET ATTRACT MODE MESSAGE.
2. Push FIRE button.
3. Depress ADVANCE.
4. Enter up to two lines of your message following instructions on the screen
5. Depress ADVANCE to terminate process.

To restore the Williams attract mode message, perform steps 1 through 3 and then turn the game OFF and back ON.

SETTING HIGH SCORE NAME

1. Position cursor on SET HIGHEST SCORE NAME.
2. Push FIRE button.
3. Depress ADVANCE.
4. Enter new signature; depress ADVANCE to terminate process.

An alternate, simpler method enters the factory highest score signature. In the game over mode, hold HIGH SCORE RESET Depressed. After a few seconds a sound is produced and the factory highest score signature has been activated.

Table 1. Game Pricing

Coin Door Mechanism	Credits/ Money	Pricing Selection	Left Slot Units	Centre Slot Units	Right Slot Units	Units Per Credit	Units Req'd For Bonus Credit	Min Units For Any Credit
Twin Quarter Quarter, Dollar, Quarter	1/25¢, 5/$1	0	1	4	1	1	4	0
	2/50¢, 5/$1	0	1	4	1	1	4	2
	• **1/25¢, 4/$1**	**3**	**1**	**4**	**1**	**1**	**0**	**0**
	2/50¢, 4/$1	0	1	4	1	1	0	2
	1/50¢, 3/$1, 4/$1.25	0	3	12	3	4	15	0
	1/50¢, 3/$1, 7/$2	0	12	48	12	14	96	24
	• **1/50¢, 3/$1, 6/$2**	**1**	**1**	**4**	**1**	**2**	**4**	**0**
	• **1/50¢**	**5**	**1**	**4**	**1**	**2**	**0**	**0**
1DM, 5DM	• **1/1DM, 6/5DM**	**2**	**6**	**0**	**1**	**1**	**0**	**0**
20-Cent, 50-Cent	1/20¢, 3/50¢	0	6	0	15	5	0	0
1 Franc, 5 Franc	• **1/2F, 3/5F**	**4**	**4**	**16**	**6**	**2**	**0**	**0**
25 Cent	• **1/25¢, 4/1G**	**6**	**1**	**0**	**4**	**1**	**0**	**0**
1 Guilder	1/25¢, 5/1G	0	1	0	4	1	4	0
5 Franc	• **1/5F, 2/10F**	**7**	**1**	**0**	**2**	**1**	**0**	**0**
10 Franc	• **1/10F**	**8**	**1**	**0**	**2**	**2**	**0**	**0**
1 Franc, 2 Franc	• **2/1F 5/2F**	**2**	**6**	**0**	**1**	**1**	**0**	**0**
100 Lire, 200 Lire	• **1/200 Lire**	**8**	**1**	**0**	**2**	**2**	**0**	**0**
Twin Coin	• **1/1 Coin**	**3**	**1**	**4**	**1**	**1**	**0**	**0**
	• **1/2 Coins**	**5**	**1**	**4**	**1**	**2**	**0**	**0**
	1/3 Coins, 2 5 Coins	0	2	0	2	5	0	0
1-Unit, 5-Unit	• **1/2, 3/5**	**4**	**1**	**16**	**6**	**2**	**0**	**0**
	1/1, 5/5	0	1	0	5	1	0	0
	1/3, 2/5	0	2	0	10	5	0	0
Any	• **Free Play**	**9**	**1**	**4**	**1**	**1**	**0**	**0**

Definitions of Pricing Terms

PRICING SELECTION allows a *shorthand* method of setting the pricing functions. If a number from one to nine is entered into the PRICING SELECTION function, a corresponding standard setting (shown in bold type above) will be entered into the game. *The rest of the pricing functions are automatically set for that standard.*

THE PRICE OF ONE GAME (number of coins per game) is equal to the number of SLOT UNITS for any one slot divided by the number of UNITS PER CREDIT. If the number of LEFT SLOT UNITS (or RIGHT SLOT UNITS) equals *X* and the number of UNITS PER CREDIT equals *Y*, then the *price of one game is X/Y*

UNITS REQUIRED FOR BONUS CREDIT is the number of games that must be purchased before a free game is awarded.

MINIMUM UNITS FOR ANY CREDIT is the least number of coins allowed per game or games. Or put another way, the MIMIMUM UNITS FOR ANY CREDIT determines the smallest number of whole games that may be paid for at one time.

For example if an operator wants to allow one play for a quarter but wishes to encourage multiple game playing, he may enter:

- "0" in the PRICING SELECTION function

This zero value automatically sets all pricing functions. However minimum units for any credit must be raised to "2" or higher value to achieve the operators goal. Here are the rest of the functions as they should appear.

- "1" in the LEFT SLOT UNITS function
- "4" in the CENTER SLOT UNITS function
- "1" in the RIGHT SLOT UNITS function
- "1" in the UNITS PER CREDIT function
- "0" in the UNITS REQUIRED FOR BONUS CREDIT function
- "2" in the MINIMUM UNITS FOR ANY CREDIT function

These values allow one game to be played for a quarter, but ONLY when two or more games are paid for at a time. Incidentally, the "4" in the CENTER SLOT UNITS allows four games per dollar coin (centre slot only). See "2/50¢, 4/$1" above.

SAMPLE SETTINGS

Before adjusting EXTRA SHIPS settings, review the chart to see how they affect the extra ship score.

LET
FIRST EXTRA SHIP AT = **F**
ADDITIONAL EXTRA SHIP POINTS FACTOR = **A**

EXTRA SHIP	FORMULA[1]	F = 10,000 A = 0000	F = 10,000 A = 10,000	F = 30,000 A = 10,000	F = 10,000 A = 30,000
1st	F	10,000	10,000	30,000	10,000
2nd	2F + 1A	20,000	30,000	70,000	50,000
3rd	3F + 3A	30,000	60,000	120,000	120,000
4th	4F + 6A	40,000	100,000	180,000	220,000
5th	5F + 10A	50,000	150,000	250,000	350,000

1This series is derived from:

$$nF + \frac{(n^2-n)A}{2}$$

where n is the extra ship no.

CHAPTER 3 Troubleshooting Procedures

Introduction
Power-Up Tests
+5v DC Power Supply Adjustments
Self-Diagnostics
Diagnostic Mode Tests
Sound Board Diagnostics
CMOS RAM Data Test Protocol

INTRODUCTION

Certain types of game malfunctions may inhibit the game's diagnostic or display faculties. Troubleshooting procedures for most of these types of malfunctions as well as malfunctions that permit self-diagnosis are covered below. Our troubleshooting algorithm begins with **Power-Up** and continues until **Game Over Mode**. All procedures can be performed with minimal test equipment or merely by observing the game itself.

POWER-UP TESTS

NO GENERAL ILLUMINATION	NO INITIAL VIDEO (RUG PATTERN)	CHECKING POWER SUPPLY BOARD
(1) Check fuse F2 on power supply board. (2) Check for proper installation of jumpers W1, W2, W3 and/or resistor R27. (Some machines DO NOT have an R27. Refer to your drawing set.) (3) Check 4P1/J I, 4P3/J3, 6P2/J2 and 6P3/J3. (4) If all the above don't turn up the problem check power supply board.	(1) Press reset button on CPU Board. (2) Try RAM and ROM tests (see below) (3) If all the above don't turn up the problem, check power supply board.	(1) Swap power supply board with one from known-good game. (2) If game plays, problem is on power supply board. (3) If game doesn't play, check power transformer with voltmeter. (4) If known-good power supply is unavailable for tests above, check +5V, –5V and + 12V outputs on power supply in game. Each MUST BE within 2% of rated output with less than 0.1% AC hum.

MORE POWER-UP TESTS

TEST	ROM BOARD LEDs RECOGNIZE CONDITION	ROM BOARD LEDs IDENTIFY BAD CHIPS	VIDEO	REMEDY
GENERAL	"0" means all power-up tests passed	-	(1) Scanning rug pattern (2) Stationary rug pattern (3) "INITIAL TESTS INDICATE ALL SYSTEMS GO" (4) Game-Over Mode	If any video (see left) is missing or error message is displayed, proceed to **Diagnostic Mode** tests.
CMOS (See Appendix A)	"0" means tests passed	-	"HIGH SCORE TABLE RESET" "BOOKKEEPING TOTALS CLEARED" "ADJUSTMENT FAILURE" "RESTORE FACTORY SEITINGS BY OPENING FRONT AND TURNING GAME OFF AND ON"	(1) Open coin door and turn power off and on.
	"0" means tests passed	-	"FACTORY SEITINGS RESTORED"	(2) Press ADVANCE. Game should return to Game-Over Mode.
BATTERY (See Appendix A)	"0" means tests passed	-	"HIGH SCORE TABLE RESET" "BOOKKEEPING TOTALS CLEARED" "ADJUSTMENT FAILURE" "RESTORE FACTORY SEITINGS BY OPENING FRONT AND TURNING GAME OFF AND ON"	(1) Open coin door and turn power off and on. Or press ADVANCE. In either case, game should return to Game-Over Mode. (2) Check AA alkaline cells on CPU Board. (3) If problem persists proceed with CMOS RAM test by putting the game into its **Diagnostic Mode** (see SELF-DIAGNOSTICS).
MEMORY PROTECT INTERLOCK (See Appendix A)	"0" means tests passed	-	"HIGH SCORE TABLE RESET" "BOOKKEEPING TOTALS CLEARED" "ADJUSTMENT FAILURE" "RESTORE FACTORY SEITINGS BY OPENING FRONT AND TURNING GAME OFF AND ON"	(1) Making and breaking coin door interlock switch, check with VOM and replace if faulty. (2) Replace if faulty: Memory protect gates 6E, IC1, QI, or CMOS RAM 1C.
SPECIAL CHIP	"0" means tests passed	-	(1) Scanning rug pattern. (2) Blank screen instead of "INITIAL TESTS INDICATE: OPERATIONAL" (3) High score table with no scores. (4) Intro blank or program crash.	(1) Turn power off. (2) To find bad chip replace 2 special chips one at a time with known good chips. (3) Turn Machine on after each replacement and run through Power-Up Tests.

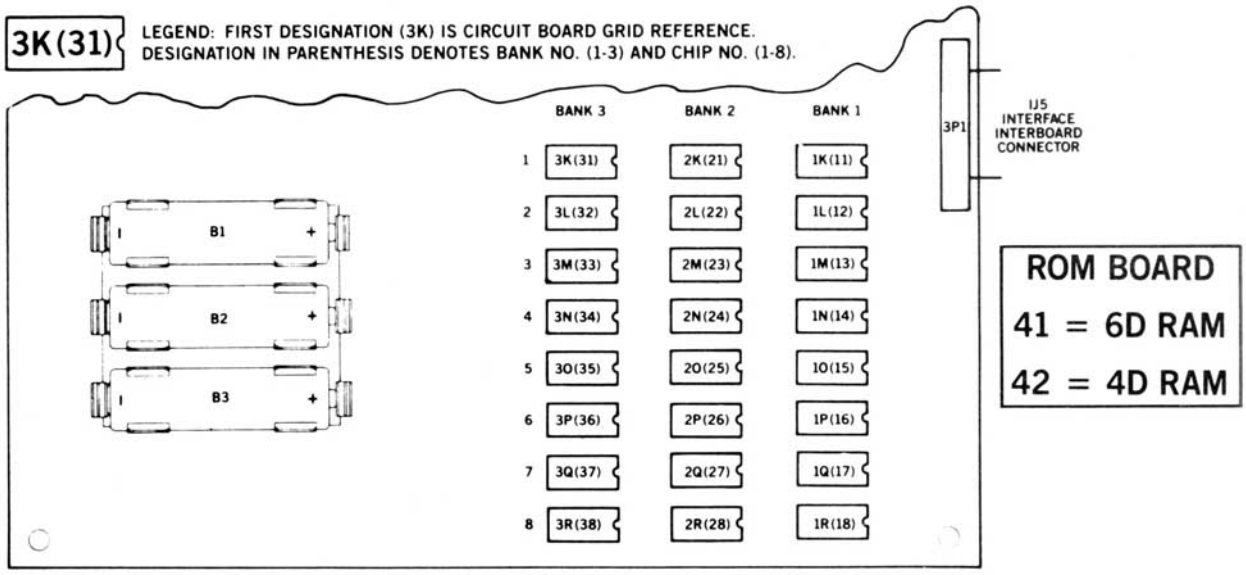


Figure 4. RAM Location and Numbering on the CPU Board & ROM Board RAMs

+5v DC Power Supply Adjustments

Before adjusting the voltage output, always check the output at the supply for AC hum. This hum should never rise above 0.005v on the +5v DC supply. If it does, consult your schematic drawing set for proper DC voltages throughout the circuit.

Test for these with the DC setting of your multimeter. Make a second check using the AC setting. Pay particular attention to readings at TP5 (top of capacitor C10). If the voltage here is too low (less than +11v DC) or you find excessive ripple (more than 700mv rms), replace the capacitor.

If TP1 is less than +4.95v DC remove R10. If TP1 is still less than +4.95v DC, the check precision resistors R25 and R26. If they are within 1% tolerance, the check IC2.

Self-Diagnostics

If RAM or ROM failure messages are displayed on the CRT after the “rug pattern” proceed with self-diagnostics. Self-diagnostic procedures are controlled by the AUTO-UP/MANUAL-DOWN and ADVANCE switches in the coin door. (See Figure 1.)

Set the AUTO-UP/MANUAL-DOWN switch to the MANUAL-DOWN position and depress the ADVANCE pushbutton. The game is now in its **Diagnostic Mode** and a ROM test is performed. With ROM test results present on the CRT display, depressing the ADVANCE pushbutton initiates the RAM test.

Further tests (CMOS, sound, switch, colour RAM, monitor test patterns) are encountered one after the other as the ADVANCE pushbutton is depressed (once more for each subsequent test).

MONITOR TEST PATTERNS *(19" Monitor Upright Games Only).* For ease in monitor adjustments, the monitor may be slid back and the screen viewed in the CRT mirror provided on the inside-top of the cabinet.

Remove the two bolts and carefully slide the monitor back in its shelf; secure the monitor in the extended position by inserting the two bolts though holes in the monitor base and monitor shelf provided at the left side of the monitor.

AUTO CYCLE MODE - From the colour bar pattern (or Game Over with the switch set to AUTO-UP) depress ADVANCE two times to display GAME ADJUSTMENTS.

1. Position the cursor on AUTO CYCLE with the Joystick and push the FIRE button.
2. Depress ADVANCE.
3. The system will now sequence through ROM, RAM, and CMOS RAM tests repeatedly. The coin door must be open during the Auto Cycle test. If an error is detected, the test is terminated and the failure indication is displayed on the CRT.
4. To terminate the Auto-Cycle test, turn the game OFF and ON.

TROUBLESHOOTING PROCEDURES: DIAGNOSTIC MODE TESTS

TEST	ROM BOARD LEDs RECOGNIZE CONDITION	ROM BOARD LEDs IDENTIFY CHIPS	VIDEO	REMEDY
ROM	"2" means ROM error	2-digit ROM chip number	"ROM ERROR" and ROM chip number.	(1) Turn power off. (2) Replace suspected chip.
RAM	"1" means RAM error	Bank number first, then chip number in bank (see figure 4) *(For RAM Error 41 or 42 See Note)	"RAM ERROR" followed by RAM bank number and chip number (Note: with multiple RAM failures this display may not appear)	*(1) Check for normal voltages on indicated RAM chip: -5v/pin 1, +12v/pin 8, +5v/pin 9. (2) Turn power off. (3) Replace suspected chip. (4) With multiple RAM failures always check power supply. See POWER-UP TESTS.
CMOS (See Appendix A)	"3" means CMOS RAM error	-	"CMOS RAM ERROR OR WRITE PROTECT FAILURE"	(1) Check pin 22 of CMOS RAM for +3.2VDC minimum. If present, replace CMOS chip 1C. If absent replace AA alkaline cells. (2) With new alkaline cells, check for +3.8v DC. If still absent, replace diodes D9 and D10. (3) Upon power-up and re-entry into diagnostics if CMOS error message persists, check CMOS RAM memory protect and address decoding circuits with a logic probe.

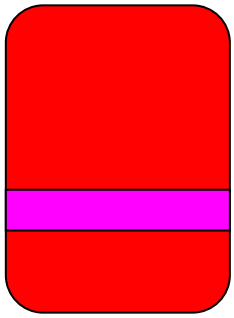
Tests 4 and 7 provide sequential subtests. To stop automatic cycling set switch to MANUAL-DOWN. Depress advance in MANUAL-DOWN to step through subtests. LED indications are not made for these tests.

<table>
<tr><th>TEST & PROCEDURES</th><th>VIDEO</th><th>REMEDY OR ADJUSTMENT</th></tr>
<tr><td>SOUND
(Test 4)</td><td>"SOUND LINE 1"
"SOUND LINE 2"
"SOUND LINE 3"
"SOUND LINE 4"
"SOUND LINE 5"
"SOUND LINE 6"
(These appear one at a time)</td><td>Missing — Check
1 — 2P4/IOP3 Pin 3
2 — 2P4/10P3 Pin 2
3 — 2P4/10P3 Pin 5
4 — 2P4/10P3 Pin 4
5 — 2P4/10P3 Pin 7
6 — 2P4/10P3 Pin 6
All — Perform Sound Board Diagnostics (see below)
NOTE: If any two sounds are the same, check for a short between the select lines with the same sound.</td></tr>
<tr><td>SWITCH TEST
(Test 5)
(1) Set switch to MANUAL-DOWN and clear any stuck switches.
(2) CRT should indicate no switches closed.
(3) Operate switches and check for display of switch name.</td><td>CRT indicates AUTO-UP closed and any stuck switches. CRT Display for Each Switch . . .
ROM BOARD
ADVANCE
AUTO-UP
HIGH SCORE
RESET
LEFT COIN
CENTRE COIN
RIGHT COIN'
SLAM SWITCH
INTERFACE BOARD
1- PLAYER START
2- PLAYER START
UP-DOWN A1
UP-DOWN B1
UP-DOWN C1
UP-DOWN DIRECTION 1
RIGHT-LEFT A1
RIGHT-LEFT B1
RIGHT-LEFT C1
RIGHT-LEFT DIRECTION 1
FIRE 1
SINIBOMB 1</td><td>(Refer to CABINET WIRING Diagram)
(1) COIN DOOR SWITCH STUCK: Disconnect 2P3
(2) PLAYER PANEL SWITCH STUCK: Disconnect 3P2 or 3P3
(3) COIN DOOR SWITCH DOES NOT OPERATE: Ground corresponding pin of 2P3.
(4) PLAYER PANEL SWITCH DOES NOT OPERATE: Ground corresponding pin of 3P2 or 3P3
□ SYMPTOM REMAINS SAME . . .ROM Board or Interface Board Faulty.
□ SYMPTOM CLEARS UP . . .Problem is in switches or wiring
ADDITIONAL TESTS FOR OPTOSWITCHES:
(5) Check that +5v DC is at pin 1 or 12P1.
(6) With joystick in centre position, check for 0.7v at base of ON transistor(s) (Q1 thru Q6) and 0.1v at pin(s) 2, 3, 4, 6, 7 and 8 of 12P1
(7) With joystick moved from centre position, check for 0.1v at base of OFF transistor(s) and 5v at pin(s) 2, 3, 4, 6, 7 and 8 of 12P1
(8) With joystick in centre position, check for 5v at pin(s) 5 and 9 of 12P1. With Joystick in Down (Left) position, check for +5v at pin 5 (9) of 12P1. With Joystick in Up (Right) position, check for +0v at pin 5 (9) of 12P1.</td></tr>
</table>

NOTE: Two static RAMs located on the ROM board are indicated as RAM 41 in chip location 6D and RAM 42 in chip location 4D.

MORE DIAGNOSTIC MODE TESTS

<table>
<tr><th>TEST & PROCEDURES</th><th>VIDEO SEQUENCES</th><th colspan="2">REMEDY OR ADJUSTMENT</th></tr>
<tr><td rowspan="7">COLOUR RAM TEST
(Test 6)
Note that a blank sequence or two sequences with the same shade indicate a faulty 1A flip-flop, 1B RAM or 2B RAM or a failure in the colour analogue circuit. Check voltages on Q1 (green transistor), Q2 (red transistor) and Q3 (blue transistor). During the eight full screen colour tests, the base voltage (centre Pin) on each transistor should vary between 3.8v (brightest colour) and 4.4v (no colour)

Colour RAM check
(1) CRT sequences through 8 colours, 2 seconds each
(2) Thick vertical band indicates colour RAM fault.
  </td><td></td><td>REPLACE RAM 1B</td><td>REPLACE RAM 2B</td></tr>
<tr><td>1) light red screen
2) red screen
3) dark red screen</td><td>too-light or
too-dark red
or grey band</td><td>magenta band</td></tr>
<tr><td>4) light green screen
5) green screen
6) dark green screen</td><td>yellow band</td><td>cyan band</td></tr>
<tr><td>7) light blue screen
8) blue screen</td><td>magenta band</td><td>too-light or too
-dark blue or
grey band</td></tr>
<tr><td>4) light green screen</td><td>green band</td><td>dark green band
or grey band</td></tr>
<tr><td>5) green screen</td><td>light green band</td><td>dark green band
or grey band</td></tr>
<tr><td>6) dark green screen</td><td>-</td><td>grey band</td></tr>
<tr><td rowspan="3">MONITOR & COLOUR RAM TEST
(Test 7)

Colour Bar Pattern</td><td>cross hatch pattern</td><td colspan="2">Aids you in setting up vertical and horizontal linearity, convergence and focus.</td></tr>
<tr><td>red screen
green screen
blue screen
colour bars</td><td colspan="2">Aids you in optimising colour purity</td></tr>
<tr><td>colour bars
• double-width
• half-width
• transposed
• missing</td><td colspan="2">If colour RAM test 6 indicates no faults, symptoms at left suggest a fault in 1A, 1B, 2B or 2C chips.</td></tr>
</table>

SOUND BOARD DIAGNOSTICS

SYMPTOM	TEST & PROCEDURES		
MISSING SOUNDS NO SOUND-STEP 1 *(ASSUMPTION: INPUT SECTION FAILURE)*	**CHECK SOUND SELECT INPUTS**		
	TEST	**TOOL**	**CONDTION & REMEDY**
	Sound board connector 10P3/J3-2 to 7	Logic Probe (Game on and in test 4)	• PULSING - Proceed. • LOW - check jacks, foils. • STILL LOW - Perform ROM board checkbox below.
	SR1 DIP resistors R3 to R9	VOM - Reading ohms (game off)	• ALL 4.7K - Proceed. • ANY OPEN - replace SR1.
	C3 to C9	VOM - Reading ohms (game off)	• ALL OK - Proceed. • ANY SHORTED - replace bad.
	IC 5-1, IC 7-14 (power pins)	Logic Probe (Game on and in test 4)	• HIGH - Proceed. • LOW - Replace C19 (IC5) or C21 (IC7). • STILL LOW - Replace bad IC.
	IC5-2, 4, 6, 10, 12, 15 IC7-4, 6	Logic Probe (Game on and in test 4)	• PULSING - Proceed. • LOW - Replace bad chip.
	IC10-18, 19 (PIA)	Logic Probe (Game on and in test 4)	• PULSING - Proceed. • LIFT C20 - Retest. • PULSING NOW - Replace C20. • STILL LOW - Replace IC6, retest.
	IC10-10 to 17 (PIA)	Logic Probe (Game on and in test 4)	• PULSING - Proceed. • SOME LOW Replace IC. • ALL LOW - Lift C31, retest. • PULSING NOW - Replace C31. • STILL LOW - Replace IC

NOTE: In cockpit model games where no sounds are produced from either sound board, disconnect both 9-pin connectors from one board and then the other. This isolates faults to a single Sound Board. If sounds are still nit produced from either board check ROM Board outputs on page 19 first.

SOUND BOARD DIAGNOSTICS

<table>
<tr><th>SYMPTOM</th><th colspan="3">TEST & PROCEDURES</th></tr>
<tr><td rowspan="5">MISSING SOUNDS:
NO SOUND--STEP 2

(ASSUMPTION OFF-BOARD FAILURE)</td><td colspan="3">☐ CHECK ROM BOARD OUTPUTS
(1) If you hear game sounds, disconnect and reconnect sound board connector 10P3/J3.
(2) You Should hear one or more game sounds. If so put the game in Diagnostic Mode Test 4 and proceed with this checkbox. If not go ahead to POWER SUPPLY checkbox below.</td></tr>
<tr><td>TEST</td><td>TOOL</td><td>CONDTION & REMEDY</td></tr>
<tr><td>ROM board connector 2P4/J4-2 to 7</td><td>logic probe (game on and in test 4)</td><td>• PULSING - Repair cable to sound board.
• ANY LOW - Replace jack or foil, proceed.</td></tr>
<tr><td>9C DIP resistors 2 to 8</td><td>VOM - Reading ohms (game off)</td><td>• ALL 4.7K - Proceed.
• ANY OPEN - replace 9C.</td></tr>
<tr><td>C40-53</td><td>VOM - Reading ohms (game off)</td><td>• ALL OK - Proceed.
• ANY SHORTED - replace bad.</td></tr>
<tr><td>8C-10 to 15 (PIA)</td><td>logic probe (game on and in test 4)</td><td>• PULSING - Proceed.
• SOME LOW Replace 8C.</td></tr>
<tr><td>NO SOUND

(ASSUMPTION: POWER SECTION FAILURE)</td><td colspan="3">☐ CHECK ON-BOARD POWER SUPPLY
(1) With power off test for fuse continuity at F1 and F2.
(2) With power on check for +12v unregulated DC at TP1 and pin 5 of IC1.
(3) Now check for +5v regulated DC between TP4 and TP3. If voltages are absent or low turn off game and lift one pin of filter capacitors C25, C26 and C27.
(4) Check each with ohmmeter for possible short circuits.
(5) If capacitors are good and unregulated voltages test okay but you're missing +5v, replace regulator chip (IC8).</td></tr>
<tr><td>STILL NO SOUND

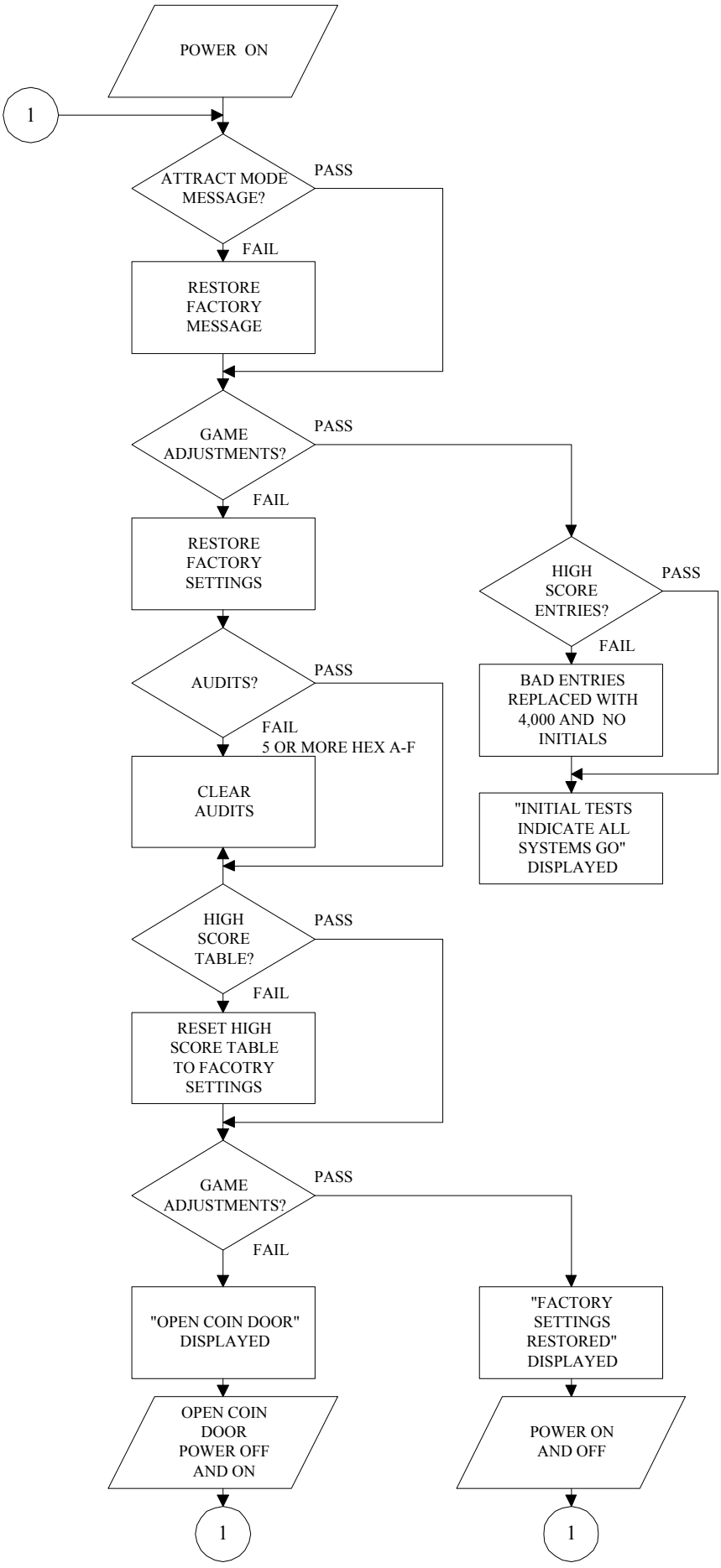
(ASSUMPTION: AUDIO SECTION FAILURE)</td><td colspan="3">☐ CHECK AUDIO (ANALOG) SECTION
(1) Turn power on; turn up volume control. Momentarily place powered-up AC soldering pencil on final amplifiers input pin (IC1, pin 1 or 10P4, pin 2) If you hear low hum, audio IC, volume pot and speaker are okay.
(2) Repeat test at Q2 emitter. If you hear hum, analogue section is okay. Step (1) will also work if you simply touch amplifiers input pin. However output level of hum will be much lower than with soldering iron. DO NOT use a soldering pencil over 40 watts. Cordless models will NOT work here.</td></tr>
<tr><td>MISSING SOUNDS;
NO SOUND

(ASSUMPTION: DIGITAL FAILURE)</td><td colspan="3">☐ CHECK SOUND ROM 12 AND RELATED CIRCUITRY
(1) Turn power on.
(2) If you have no game sounds but power supply tests show normal voltages and no ripple on +5v, check crystal clock circuit. Using DVM or logic probe, test for pulsing AC across crystal. If clock signal's absent replace crystal and associated capacitors.
(3) Turn off power.
(4) Swap sound ROM (IC12) and microprocessor chip (IC9) with known-good chips.
(5) Power up and test Sound Board after each swap by pushing DIAGNOSTIC button.</td></tr>
</table>

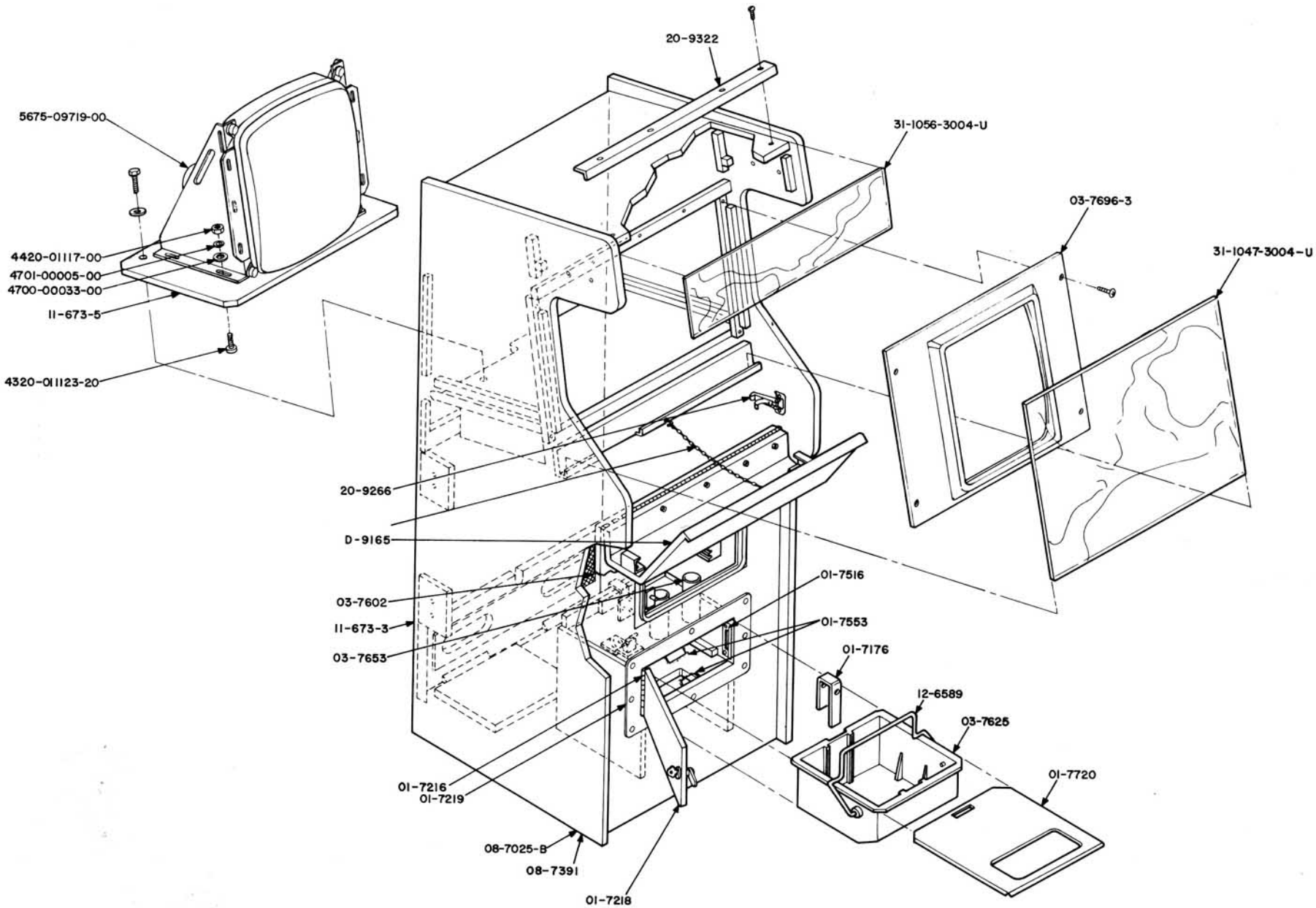
CMOS RAM Data Test Protocol

The first sub-test of the CMOS RAM data is that of the ATTRACT MODE MESSAGE checksum. If the test does not pass, the factory ATTRACT MODE MESSAGE is restored. Next, the game adjustments are checked and restored to factory settings if an error is found. If game adjustments are found intact, the high score table is checked for any bad entries. Bad entries are replaced with a score of 4,000 points and no initials. If all entries check, the game returns to the Game Over Mode.

If game adjustments are restored to factory settings, the AUDIT TOTALS are checked. If 5 or more audit digits are other than 0-9 (that is hexadecimal A through F) all audit totals are cleared. This is followed by a check of the high score table and the table is reset to factory settings if errors are found. Finally, game adjustments are rechecked and either OPEN COIN DOOR or FACTORY SETTINGS RESTORED is displayed. With the former, open the coin door and turn the game OFF and ON and then FACTORY SETTINGS RESTORED will be displayed. Return to game over by depressing the ADVANCE pushbutton or by turning the game OFF and ON a second time.



CHAPTER 4 Parts Information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31-1056-3004-U
03-7696-3
31-1047-3004-U
20-9266
D-9165
03-7602
11-673-3
03-7653
01-7516
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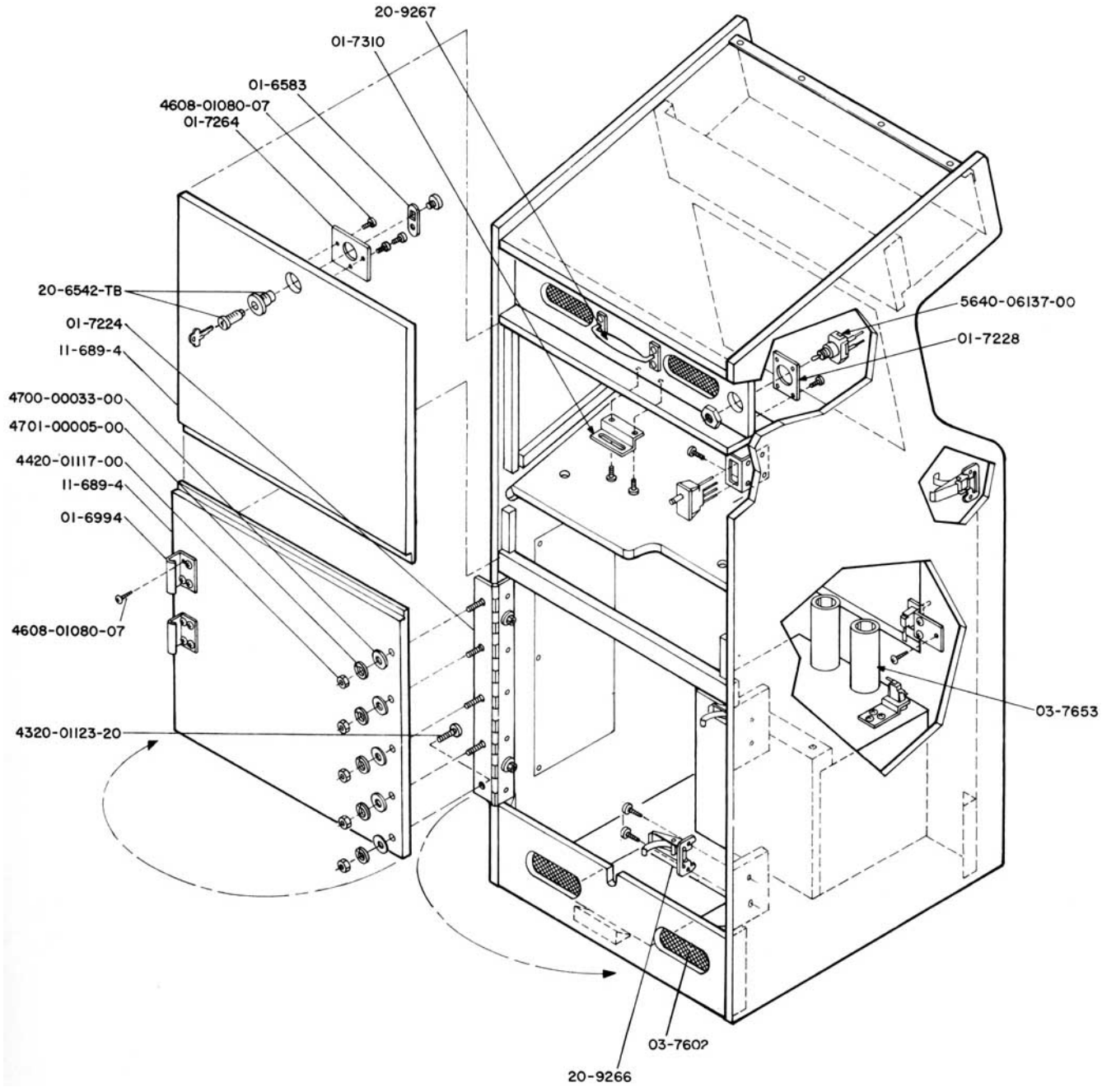
01-7218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4420-01117-00
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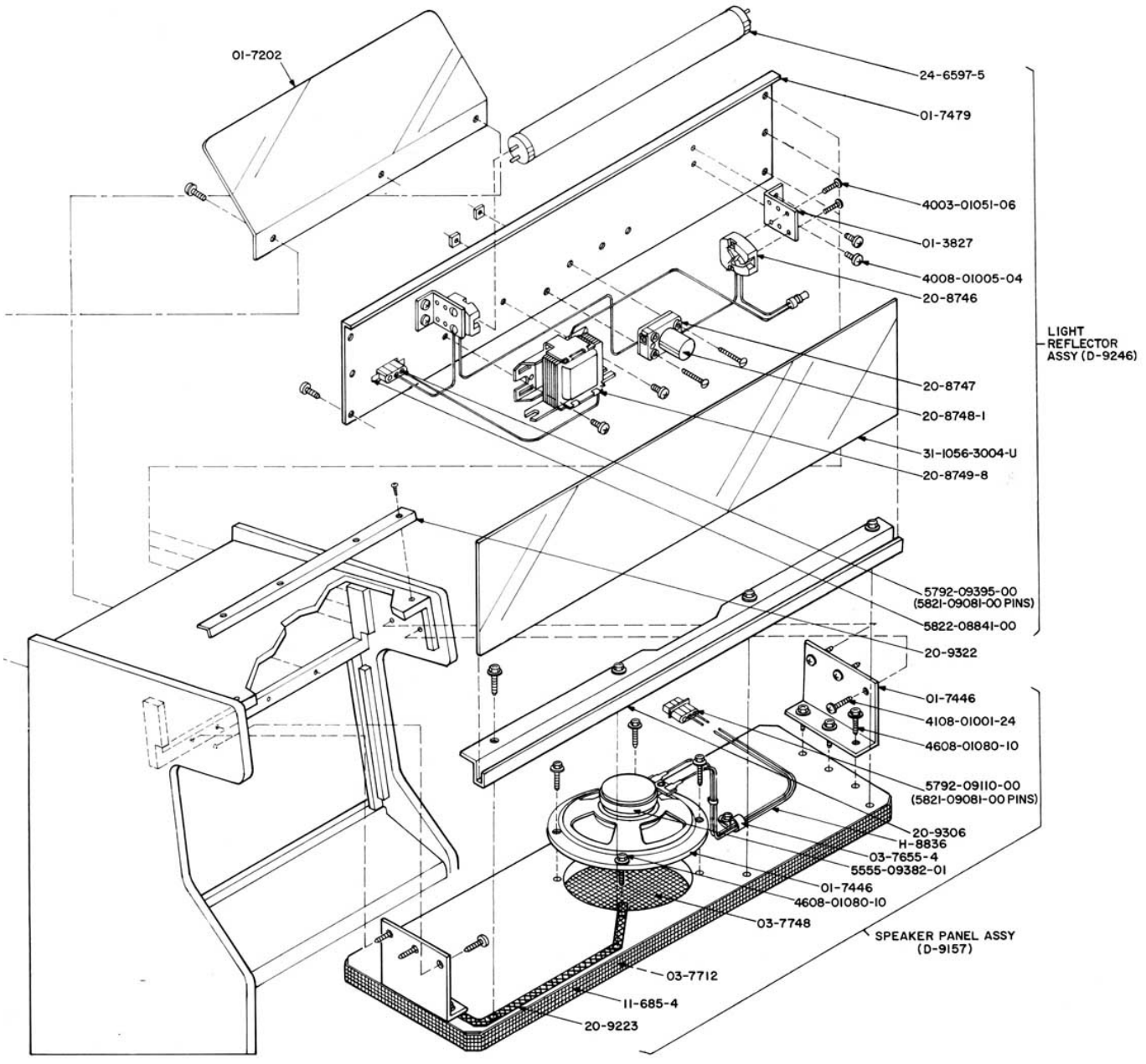
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01-7479
4003-01051-06
01-3827
4008-01005-04
20-8746
20-8747
20-8748-1
31-1056-3004-U
20-8749-8
LIGHT REFLECTOR ASSY (D-9246)
5792-09395-00 (5821-09081-00 PINS)
5822-08841-00
20-9322
01-7446
4108-01001-24
4608-01080-10
5792-09110-00 (5821-09081-00 PINS)
20-9306
H-8836
03-7655-4
5555-09382-01
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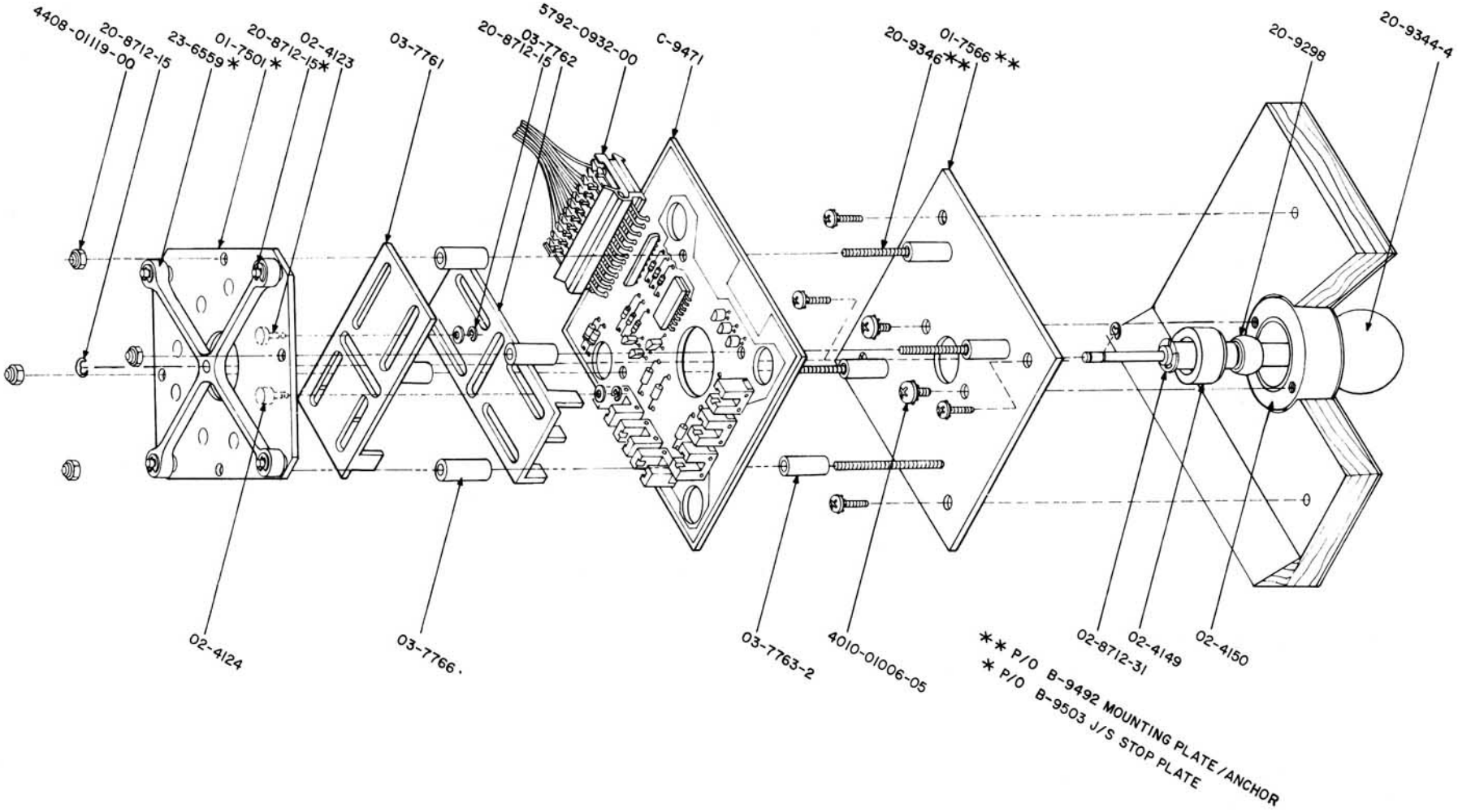
11-685-4
20-9223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01-7501 *
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5792-0932-00
C-9471
20-9346**
01-7566 **
20-9298
20-9344-4
02-4124
03-7766
03-7763-2
4010-01006-05
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02-4149
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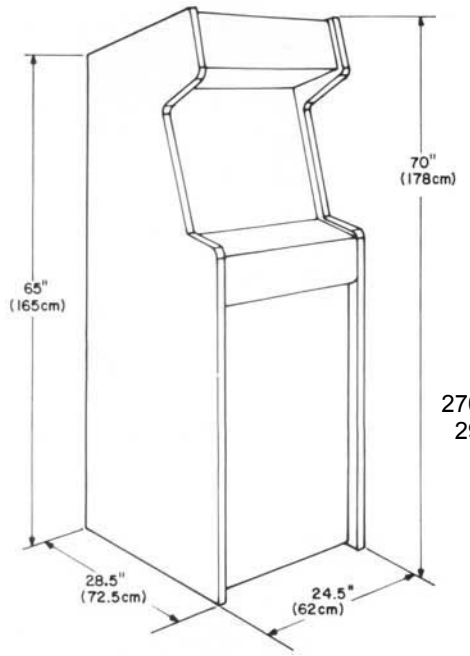
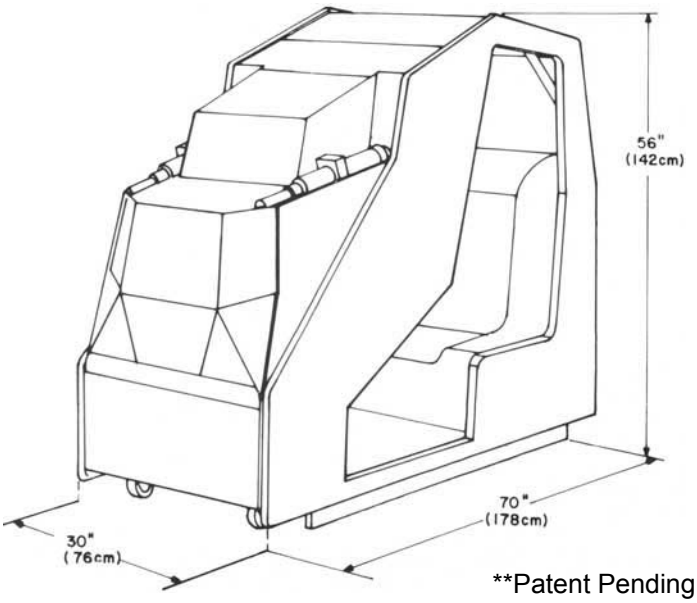
** P/O B-9492 MOUNTING PLATE/ANCHOR
* P/O B-9503 J/S STOP PLATE



UPRIGHT:
Weight
270lbs (122.5 Kg.) uncrated
290lbs (131.5 Kg.) crated

COCKPIT:
Weight
342lbs (155 Kg.) uncrated
402lbs (182.5 Kg.) crated



**Patent Pending
Specifications subject to change without notice.

Warning - This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. As temporarily permitted by regulation it has not been tested for compliance pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

POWER REQUIREMENTS
115/230v AC Nominal, 50/60 Hz
@1.7/0.85A 192W
(20A surge for one cycle at power turn on)

Normal Line = 98-126v AC
196-252v AC

High Line* = 98-126v AC
196-252v AC

Low Line* = 98-126v AC
196-252v AC

*Transformer Jumpers Required.
See Service Manual.

ENVIRONMENT
Operating Temperature
0^0 to $+45^0$C ambient
($+32^0$ to $+113^0$F)

Storage Temperature
-40^0 to $+65^0$C ambient
(-40^0 to $+149^0$F)
90% RH at 40^0 (104^0F), non-condensing

MONITOR
19" Colour Raster
non-interlaced
UL, CSA & DHHS Approved

VIDEO SYSYTEM**
256 Colours, 340 x 240 PIXEL Resolution
6809E Microprocessor
ROM: 44K BYTES
Video and Scratch RAM: 50 K BYTES
CMOS RAM: 1Kx4
SPECIAL RAM 2K BYTES

SOUND SYSTEM**
6808 Microprocessor
ROM: 24K BYTES (cockpit)
U.S. Patent No. 4272649

SPEECH SYSTEM**
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CVSD System

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(6 separate speeds in 8 directions plus
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